AD-774 841

ALPHA-DOT: A NEW APPROACH TO DIRECT COMPUTER ENTRY OF BATTLEFIELD DATA

Raymond C. Sidorsky

Army Research Institute for Behavioral and Social Sciences
Arlington, Virginia

January 1974

U. S. ARMY RESEARCH INSTITUTE

FOR THE BEHAVIORAL AND SOCIAL SCIENCES

An activity of the Chief, Research and Development

R. A. ROOTH
COL, GS
Commander

J. E. UHLANER
Technical Director

ACCESSION for
NTIS White Section
DDC Buff Section
UNANNOUNCED
JUSTIFICATION ....
BY ....
DISTRIBUTION/AVAILABILITY CODES
Dist. AVAIL. [illegible]
A

NOTICES

DISTRIBUTION: Primary distribution of this report has been made by ARI. Please address correspondence concerning distribution of reports to: U. S. Army Research Institute for the Behavioral and Social Sciences, ATTN: RDMR-P, 1300 Wilson Boulevard, Arlington, Virginia 22209.

FINAL DISPOSITION: This report may be destroyed when it is no longer needed. Please do not return it to the U. S. Army Research Institute for the Behavioral and Social Sciences.

NOTE: The findings in this report are not to be construed as an official Department of the Army position, unless so designated by other authorized documents.

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

AD-774841

REPORT DOCUMENTATION PAGE

READ INSTRUCTIONS BEFORE COMPLETING FORM

1. REPORT NUMBER: Technical Paper 249	2. GOVT ACCESSION NO.
3. RECIPIENT'S CATALOG NUMBER	
4. TITLE (and Subtitle): ALPHA-DOT: A NEW APPROACH TO DIRECT COMPUTER ENTRY OF BATTLEFIELD DATA	5. TYPE OF REPORT & PERIOD COVERED
	6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s): Raymond C. Sidorsky	8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS: U. S. Army Research Institute for the Behavioral and Social Sciences, 1300 Wilson Blvd., Arlington, Va. 22209	10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS: 2TQ611014918
11. CONTROLLING OFFICE NAME AND ADDRESS: Project Manager Army Tactical Data Systems, US Army Training and Doctrine Command	12. REPORT DATE: January 1974
	13. NUMBER OF PAGES: ~~26~~ 24
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office)	15. SECURITY CLASS. (of this report): Unclassified
	15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Source data automation	Input procedures
Keyboard design	Message input rate
Input/Output devices	UIOD (user input/output devices)
Man-computer functions	Semi-automated information processing systems
Military Information Systems	TACFIRE TOS (tactical operations system)

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The purpose of the present study was to determine the suitability of the 5 key Alpha-dot keyboard for source data automation of battlefield information. The Alpha-dot system is a coding technique that enables people to input data using familiar shapes in a form that is also directly compatible with computers and other binary data processors. The technique can be used as the basis for a number of devices and procedures for the two-way communication of information between man and machine. Ten enlisted personnel entered both free form and formatted versions of simulated enemy situation

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

(cont)

20. spot reports. Learning time as well as rate and accuracy of data entry using the Alpha-dot keyboard was compared to operator performance using a standard typewriter.

The results indicate that no special skill is required to operate the device. All of the trainees were able to input messages satisfactorily after two or three minutes of instruction. Learning time for skilled operation is very short. Nine of the ten trainees memorized the character set within 1-1/2 hours of practice and were then able to transmit messages without reference to the guide chart. Rate of data entry compares favorably with the standard keyboard. After less than five hours of practice, free text messages were entered at 60% of each trainee's standard keyboard rate. However, formatted (TOS type) messages were transmitted at a rate equal or exceeding that of the standard keyboard. Uncorrected errors were nil with both keyboards.

The Alpha-dot technique appears to have potential as a means to increase the speed, accuracy and flexibility of input of battlefield data by frontline observers. Functional specifications for a militarized field operable unit will be developed following field tests of a prototype unit.

ii

Technical Paper 249

AD

ALPHA-DOT: A NEW APPROACH TO DIRECT COMPUTER ENTRY OF BATTLEFIELD DATA

Raymond C. Sidorsky

James D. Baker, Supervisory Project Director

SYSTEMS INTEGRATION & COMMAND/CONTROL TECHNICAL AREA
Cecil D. Johnson, Chief

Submitted By:
Joseph Zeidner, Director
ORGANIZATIONS AND SYSTEMS
RESEARCH LABORATORY

Approved By:
J. E. Uhlaner
TECHNICAL DIRECTOR

U. S. ARMY RESEARCH INSTITUTE FOR THE BEHAVIORAL AND SOCIAL SCIENCES

Office, Chief of Research and Development
Department of the Army
1300 Wilson Boulevard, Arlington, Virginia 22209

January 1974

Army Project Number
2T061101491B

Command & Control

iv

ARI Research Reports and Technical Papers are intended for sponsors of R&D tasks and other research and military agencies. Any findings ready for implementation at the time of publication are presented in the latter part of the Brief. Upon completion of a major phase of the task, formal recommendations for official action normally are conveyed to appropriate military agencies by briefing or Disposition Form.

FOREWORD

Technological advancements have led to increased speed, mobility, and destructive power of military operations. To permit commanders to make tactical decisions consistent with rapid change and succession of events, information on military operations must be processed and used more effectively than ever before. To meet this need, the Army is developing automated systems for receipts, processing, retrieval, and display of different types and vast amounts of military data. There is a concomitant requirement for research to determine how human abilities can be utilized to enable command information processing systems to function with maximum effectiveness.

ARI's manned systems research in this area is directed toward the enhancement of human performance and facilitation of man-machine interaction in relation to total system effectiveness. It involves experimentation with various configurations of systems components, considering interactions and tradeoffs. The end products--immediate or ultimate--are scientific findings on human capabilities under varying conditions within the system. The findings have implications for systems design, development, and operational use. The present publication describes an investigation of operator performance using a new form of 5 finger keyboard. Data regarding operator learning, input and error rates were collected under controlled conditions.

The entire research effort is responsive to requirements of RDT&E Project 2Q062106A723, "Human Performance in Military Systems", FY 1972 Work Program, Project 2T061101491B "In-House Laboratory Independent Research" and to the special requirements of the Project Manager, Army Tactical Data Systems and the U. S. Army Training and Doctrine Command.

J. E. UHLANER
Technical Director

ALPHA-DOT: A NEW APPROACH TO DIRECT COMPUTER ENTRY OF BATTLEFIELD DATA

BRIEF

Requirement:

To increase the effectiveness of tactical data systems through increased speed, accuracy and flexibility of data input by frontline observers.

Procedure:

The Alpha-dot system is a coding technique that enables people to input data using familiar shapes in a form that is als directly compatible with computers and other binary data processors. The technique can be used as the basis for a number of devices and procedures for two-way communication of information between man and machine. For example, data can be input via keyboards, pressure sensitive "tablets," CRT's, paper forms and other means. The purpose of the present research was to determine the suitability of the 5 key Alpha-dot keyboard for source data automation of battlefield information. Ten enlisted personnel entered both free form and formatted versions of simulated enemy situation spot reports. Learning time as well as rate and accuracy of data entry using the Alpha-dot keyboard was compared to operator performance using a standard typewriter.

Findings:

No special skill is required to operate the device. All of the trainees were able to input messages satisfactorily after two or three minutes of instruction. Learning time for skilled operation is very short. Nine of the ten trainees memorized the character set within 1½ hours of practice and were then able to transmit messages without reference to the guide chart. Rate of data entry compares favorably with the standard keyboard. After less than five hours of practice, free text messages were entered at 60% of each trainee's standard keyboard rate. However, formatted (TOS type). messages were transmitted at a rate equal to or exceeding that of the standard keyboard. Uncorrected errors were nil with both keyboards.

Utilization of Findings:

The Alpha-dot technique appears to have potential as a means of increasing the speed, accuracy and flexibility of input of battlefield data by frontline observers. Design and fabrication of a prototype message input unit capable of interfacing with the TOS or TACFIRE systems is underway. Functional specifications for a militarized field operable unit will be developed following field tests of the prototype unit.

ALPHA-DOT: A NEW APPROACH TO DIRECT COMPUTER ENTRY OF BATTLEFIELD DATA

CONTENTS

	Page
INTRODUCTION	1
METHOD	4
Apparatus	4
Keyboard Operation	4
Procedure	6
Operators	9
RESULTS	9
SELECTED BIBLIOGRAPHY	15
DISTRIBUTION	17
DD FORM 1473 (Report Documentation Page)	19

TABLES

Table 1.	Maximum data entry rates with the Alpha-dot keyboard and the standard typewriter keyboard	12
2.	Learning time and maximum rate of data entry	13

FIGURES

Figure 1.	Alpha-dot five key keyboard code	3
2.	Experimental apparatus	5
3.	Message, enemy situation spot reports	7
4.	Message, highly formatted similar to TOS	8
5.	Alpha-dot message entry device tablet type	14

ALPHA-DOT: A NEW APPROACH TO DIRECT COMPUTER ENTRY OF BATTLEFIELD DATA

INTRODUCTION

One of the most systems-limiting bottlenecks in the utilization of computers for real-time tactical operations is the lack of an effective means for the input of source data. This is true, for example, with regard to the dynamic information processing needs associated with Army tactical command and control functions. The availability of high speed computers with massive memories has not as yet had a significant impact on combat operations. Part of the problem is that in most tactical situations data from a large number of widely separated information sources must be communicated and processed very rapidly if the most effective command and control is to be achieved. Although each information source may contribute only a small portion of the total information, that portion may be a vital part of the total data flow needed to control a fluid battlefield situation in a timely and effective manner. Thus, the ability of ADP systems to assist battlefield commanders depends in part upon the rapid entry and processing of data obtained by frontline observers. For this reason the Army's present ADP design concept calls for tactical information to be put into computer-compatible form as early as possible.

Presently available means for acquiring such source data are unsatisfactory in terms of cost and complexity of equipment, message capabilities and demands on the operators. The TACFIRE system is currently evaluating Fixed Format Message Entry Devices which provide a bank of mechanical switches to transmit certain predefined messages in a form suitable for computer processing. While these fixed format devices may solve the immediate problem, they are only a stop-gap solution for other Integrated Battlefield Control Systems (IBCS) such as TOS, the Tactical Operations System. Not only are such devices costly, but they cannot handle the variety and complexity of spot reports and other messages transmitted by frontline observers.

In the long run, inability to capture essential information at the source will limit the overall effectiveness of tactical command and control systems. To achieve more effective source data automation, a need exists for input/output (I/O) devices that are small, low in cost, simple in design and operation and adaptable to a wide variety of man-to-man and/or man-to-computer battlefield communication needs. Devices utilizing conventional techniques, i.e., standard keyboards, push buttons, rotary or sliding switches, etc., have not been found to be satisfactory for field use. Each conventional technique has one or more limitations that can be overcome only at the expense of greatly increased cost and complexity, if at all. In an attempt to overcome those limitations the

author devised a new coding technique, the Alpha dot system. The purpose of the present project was to explore the feasibility of using the Alpha-dot principle to develop new devices and procedures that would aid the process of source data automation in the field.

The Alpha-dot system involves the use of a rectangular matrix of six dots and a specially designed set of alphanumeric characters (Figure 1). These symbols are configured so that each has associated with it a unique combination of one or more of the six dots. The Alpha-dot character set thus conveys information to humans via familiar shape coding and to machines via a binary code. The technique can be used as the basis for a variety of on-line and off-line data entry procedures. For example, it can be adapted to the entry of handprinted alphanumeric symbols using hand held implements (pen, pencil, stylus, light pen, etc.) to "write" information on paper forms, CRT's and other special surfaces.

The Alpha-dot approach can also be applied to a five-finger keyboard system that permits new types of two-way communication. Data input is effected by keypresses using the fingers of one hand, either singly or in combinations of up to a maximum of three fingers at a time. The manually entered inputs can be converted to electrical signals for machine input. They can also be converted to outputs in a humanly "readable" form as visual, auditory or tactual signals.

The combination of keys defining each Alpha-dot character has a one-to-one correspondence with the combinations of dots associated with each Alpha-dot character. That is, the key presses are determined by the shape of the character. Because of this feature, it was hypothesized that the Alpha-dot code would be easy to learn and remember. Previous attempts at five finger keyboards (Hirsch, 1956; Engelbart, 1970) have not been particularly successful because of the arbitrariness of the code and the complexity of the manual inputs. In the present case, the association of the character's shape and the corresponding digital code would appear to provide a powerful mnemonic for learning to use the code and keyboard.

The Alpha-dot approach takes advantage of the ability of humans to process information in a parallel or serial mode or a combination of these two modes. The coding elements associated with each data character are split into two separate parts or "strokes." By thus combining the parallel and serial modes of data transmission, the human's capacity to handle information is not overloaded in either mode. No more than three parallel signals and only two serial signals are used to make up the most complex symbol used in the Alpha-dot system. Furthermore, considerable evidence exists (Miller, 1956) to indicate that the most efficient information transfer occurs if the number of discriminable states of any particular stimulus dimension is set at 7 ± 2. In the basic Alpha-dot system, no signal (i.e., stroke) has more than seven states.

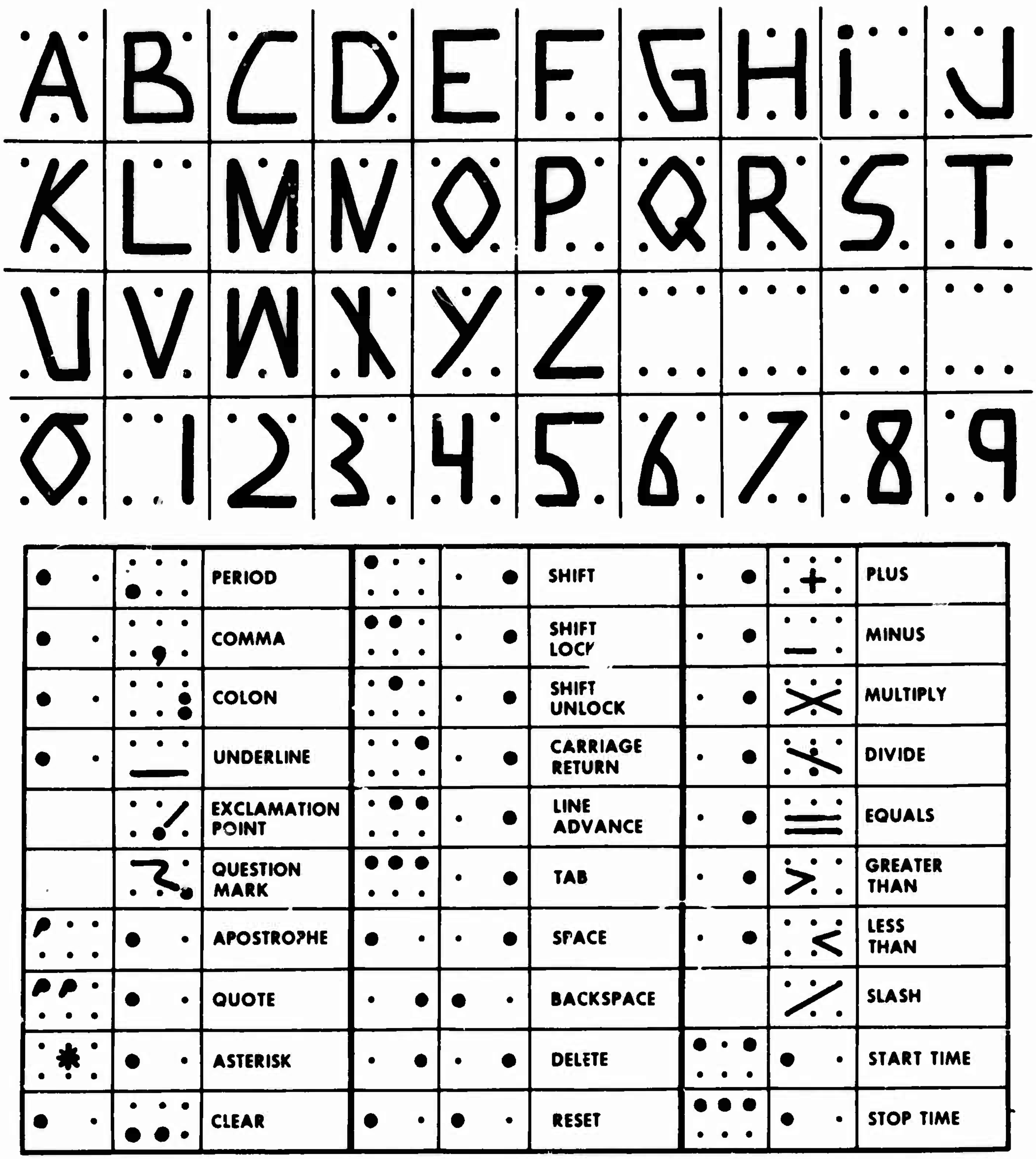


Figure 1. Alpha-dot five key keyboard code

METHOD

Apparatus: The experimental apparatus consisted of a) a five-finger keyboard, b) a CRT, and c) a set of five lights mounted in a box (Figure 2). The operators' keypresses were fed into a CDC 3300 computer. The computer was programmed to translate the operators' inputs and to display the results on a CRT, providing the operator immediate visual feedback of his inputs. The bank of five lights was used to provide feedback to the operator regarding keypress operation. Each light was connected to a corresponding key so that the operator could observe if he had failed to apply enough pressure to a particular key or if he had unintentionally applied pressure to a wrong key during a stroke. This bank of lights was used only during the first training session. After 15 minutes of practice, most subjects were able to exercise effective control over their keypresses.

Keyboard Operation: The operation of the keyboard (Figure 2) is as follows. The three center keys, the character keys, correspond to the three dots in each horizontal row of the Alpha-dot matrix. The left-most key (T) is operated by the thumb; the right key (L) is operated by the little finger. All letters and digits are entered using only the three character keys. Each character is entered using two "strokes," each stroke consisting of one or more keys pressed down simultaneously.* The letter "A," for example, is transmitted by pressing the middle key for the first stroke, followed by a second stroke consisting of the #1 and the #3 keys. The letter "B" is transmitted by pressing the first and second keys followed by a stroke of all three character keys.

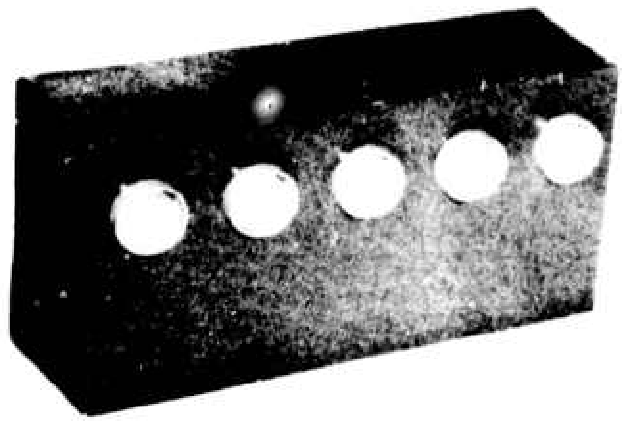
Most nonalphanumeric characters (e.g., punctuation, math symbols) and machine operations (tab, carriage return, etc.) involve the use of the thumb or little finger. These two keys operate somewhat differently, inasmuch as they are not ever used in combination with each other or any other key to form a stroke. As a result, only nine strokes are involved in the entire Alpha-dot system. Thus, although 31 different strokes or chords are possible with five fingers, every character or function in the entire Alpha-dot system involves some combination of two of the following strokes or chords: 1, 2, 3, 1+2, 1+3, 2+3, 1+2+3, T, or L. The Alpha-dot system is able to reduce the number of chords to only nine and still get a full character set by using a two-stroke entry process. It is thus possible to generate a potential character set of 81 different characters or functions.

---

*It is not necessary to press or release the keys simultaneously within a stroke. It is only necessary that the key presses overlap in time. For example, to enter a chord or stroke consisting of keys 1 and 2, the only requirement is that key #2 be pressed before key #1 is released. A stroke or chord is signalled only when all keys are released.

(B) CRT

(A) ALPHA-DOT KEYBOARD



(C) GUIDE LIGHTS

Figure 2. Experimental apparatus

Procedure: Ten subjects were each given five hours of practice with the keyboard--ten one-half hour training sessions spread over a 10 to 15 day period.

During their first session, the operators were given a brief (five minute) description of the Alpha-dot concept. They then entered the entire character set via the keyboard. A large chart showing the alphabet, digits and all other characters and functions was used as a guide. The practice was given in several phases. The aim of the initial phase was to familiarize the operator with the character set and to develop some dexterity with the keyboard. Each character was entered ten consecutive times; the complete character set was exercised a character at a time; simple sentences such as "the quick brown fox jumped over the lazy dog's back" were entered. During this first phase the operator could observe the chart and the CRT.

When the operator was able to enter the complete character set with reasonable dexterity (generally by the end of the first or second session), he performed the same operation without reference to the chart. He was permitted to observe the CRT, however, and to correct any errors he made by backspacing and inserting the correct character on the CRT. If he forgot an occasional letter, he was shown the chart. This process was continued until each operator was able to enter the complete character set and the "quick brown fox" sentence twice in a row without error.

The third phase was similar to Phase 2 except that the operator was not permitted to observe the input on the CRT. He was informed by the experimenter of errors. This process was continued until the operator entered the complete character set and the "quick brown fox" sentence twice without error. It was only after succeeding in those "blind" trials (i.e., without any visual feedback whatsoever) that the character set was considered to be learned. Once the operator had demonstrated his capability to enter the entire character set, he was told to maximize his speed.

The final phase consisted of the timed entry of simulated battlefield messages. Two types of messages were used. The first consisted of free text enemy situation spot reports (Figure 3). Each of these messages consisted of 255 characters or the equivalent of 51 five letter words. The second type consisted of highly formatted messages (Figure 4) similar to those used in automated information processing systems such as the computerized Tactical Operations System. These messages consisted of 96 entries that would require a keypress with a typewriter. In both cases the messages were specially constructed so that every letter and digit appeared at least once in the message. Any forgetting of the characters would be detected through this process.

THIS IS A PRIORITY CONFIDENTIAL ENEMY SITUATION SPOT REPORT FROM J5. THE OKCIDENTAL FIRST ARMY ENGINEER BATTALION IS LEAVING LOCATION QX49 AT 1530 HOURS, APRIL 16, 1972. THEIR PRESENT POSITION IS INDICATED BY COORDINATES K39C84, P58M12, AND Z30V97.

Figure 3. Message, enemy situation spot reports

11

```
FORM: W 2   PREC: R     SEC: U N C  ORIG: K 9
UNIT: U K _ 3 R D _ G U A R D S  TYPE: E N G  SIZE: B A T
 ACT: L E A V I N G  LOC: M Q 1 6
PERS: 4 8 0 WEAP: H O W  TIME: 1 9 1 5  DATE: 0 5 1 7 7 2
CO-1: E 3 8 X 7 6  CO-2: P 6 3 Z 7 8  CO-3: Y 4 0 J 2 2
```

Figure 4. Message, highly formatted similar to TOS

Twenty different messages of each type were presented in a different nonsystematic order to each operator each day. Each operator proceeded through the various phases at his own pace under the direction of the experimenter. When he reached a reasonable degree of proficiency, he was instructed to increase his speed as much as possible. After the operators became reasonably proficient in entering both types of spot reports, they were instructed to enter the same type of messages using the standard typewriter keyboard attached to the CRT console. It was now possible to compare the speed and accuracy of data entry with the Alpha-dot keyboard with the standard procedure.

Operators: Ten enlisted personnel (one female, nine males) served as the trainees. They ranged in ages from 18 to 31 with a mean age of 22.5. Five were classified as systems analysts, three as computer programmers, one as clerk and one as personnel specialist.

RESULTS

All of the trainees were able to operate the device satisfactorily after about two or three minutes of instruction. That is, they could enter messages by reference to the guide chart. This demonstrates that no special manipulative skill is required to transmit messages such as is required to transmit Morse code, for example. Thus, in an emergency a person with only a passing acquaintance with the operation of the device could transmit a message, albeit slowly.

Both time and error scores were obtained. The operator could correct an error by backspacing and inserting the correct character. Therefore, only those errors that remained at the end of the message were counted. Time scores were converted into a "data entry rate" score by dividing the elapsed time in seconds into the number of characters in a particular message. This value was used to obtain a "WPM" (words per minute) score. A word consists of five characters.

Separate tallies were made of the three types of materials used to test the operators. These were:

(1) All letter message (the quick brown fox sentence);

(2) Free text; mixed letters and digits (i.e. enemy situations spot report); and

(3) Formatted messages; mixed letters and digits (i.e. TOS type messages).

The type 1 message is not a representative message since it was quickly memorized by the trainees. It was used to get an idea of the rate of data entry that the operators could achieve, independent of the perceptual and short-term memory requirements involved in reading an ordinary message before transmittal.

The time or rate scores are shown in Table 1. In each case the scores were made up of the best time rate achieved by the operator during the experiment. The basic criteria for evaluating performance were the Developmental Specifications for the Message Entry Device of the TOS Operable Segment, calling for the entry of 70 characters within 150 seconds, the equivalent of 28 CPM or 5.8 WPM.

In the case of the memorized all-alphabetical sentence, the operators entered the message at an overall average rate of 13.05 WPM (65 CPM). With a free text spot report of mixed letters and digits the rate was 12.6 WPM (63 CPM). In the case of the highly formatted TOS message, the entry rate averaged about 10.9 WPM (55 CPM). Thus, after only five hours of practice, the group as a whole was able to transmit simulated field messages at twice the minimum rate required by Army specs.

The operator's message entry rates with the CRT keyboard are also shown in Table 1. Although the Alpha-dot keyboard is not intended for high volume data entry, it actually compares favorably with the standard keyboard. When the message consisted of connected sentences, data entry was 60% as fast with the five finger keyboard. But where the message consisted of nonconnected words and digits, as in a TOS message, data entry with the Alpha-dot keyboard was actually faster on the average than with the standard typewriter. Although the difference was not statistically significant, these results indicate that, at the least, the five finger keyboard would be unlikely to cause a reduction in data flow in situations such as computer entry where the data must be highly formatted. Part of the reason for the superior performance with the Alpha-dot keyboard is that the operator's free hand was available to help him keep track of his place while reading the disjointed messages. In addition, most typists who are not highly skilled must pause and visually search when typing numbers, since they are typed relatively infrequently. The visual search tends to slow people down and causes them to lose their place in the text.

Table 2 shows the amount of time it took people to learn the Alpha-dot character set. The character set was considered learned when the subjects were able to enter, without reference to the guide chart, the complete character set (letters, digits, punctuation, etc.) and the "quick brown fox" sentence twice in succession without error. Nine out of ten operators learned the entire character set within one and one-half hours of practice. The remaining operator learned within three hours. Thus, the Alpha-dot system does not appear to require a long period of training for independent use.

Table 2 also shows the highest data entry achieved by each subject on any of the timed messages. In most cases, this maximum rate was achieved with the "quick brown fox" sentence (see Table 1), but in several cases (operators 1, 4, 5 and 6) the highest rate was achieved with one of the other, more difficult types of messages. The ultimate

rate of data entry which the operators can achieve after extended practice (i.e. several weeks or months) is not determinable from the data at hand. However, Table 2 provides an empirical demonstration that average data entry rates in excess of 13.5 words per minute can be reasonably expected. Interestingly, the entry of 13.5 WPM with the Alpha-dot keyboard corresponds to a keypressing rate of 27 WPM with an ordinary keyboard, since each character requires two strokes. In other words, the level of motor skills and muscular coordination required is comparable to that required for the entry of 27 WPM on a standard typewriter. This demonstrates one of the values of the Alpha-dot approach since training of at least several weeks (if not months) duration is required to achieve a relatively error-free data entry rate of 27 WPM with the standard typewriter.

The number of uncorrected errors committed was relatively small with both the Alpha-dot and the standard keyboard. A statistical comparison was not made, however, because of the low number of errors and the fact that individualized training was given each trainee.

The Alpha-dot principle can be used to design a number of devices besides the five-finger keyboard. The author is currently instrumencing a "tablet" type of data entry device (Figure 5). This version permits the operator to enter a computer-compatible signal by literally printing the character with a stylus, or with his finger tip. Another version permits data entry using only one finger in situations where bulky mittens or other impediments are involved.

The author is also looking into new forms of message devices to improve two-way communication under battlefield conditions. In the experiment described here, people learned to enter characters using the dot patterns as a guide. Further experimentation will be conducted shortly to see if people can readily learn to "read" the dot patterns as well using their eyes, ears or fingertips. If this is the case, we expect to reduce the cost and complexity of message display devices without decreasing system effectiveness.

In addition to their military uses, devices and procedures based on the Alpha-dot principle have potential fallout as an aid for various handicapped persons. The communications capabilities of the blind, the deaf, and persons with only one hand may be greatly improved if these devices turn out to be practical for Army applications.

Table 1

MAXIMUM DATA ENTRY RATES WITH THE ALPHA-DOT KEYBOARD AND THE STANDARD TYPEWRITER KEYBOARD

Subject	Type of Message						
	All Letters*	Mixed A/N -- Text**			Mixed A/N -- Formatted***		
	WPM - Alpha-dot Keyboard	WPM - Alpha-dot Keyboard	WPM - Type-writer	% of Typing Speed	WMP - Alpha-dot Keyboard	WPM - Type-writer	% of Typing Speed
1	13.5	13.2	35.3	37.4	14.3	16.3	87.7
2	14.2	13.3	16.7	79.6	11.8	11.4	103.5
3	17.2	13.6	14.8	91.8	13.0	10.5	123.8
4	16.9	13.5	32.2	41.9	11.8	12.3	95.9
5	15.9	15.0	31.1	48.2	11.7	14.1	82.9
6	12.5	11.9	22.2	53.6	9.8	9.1	107.6
7	11.0	7.7	10.9	70.6	9.9	7.2	137.5
8	10.9				8.7	8.5	102.3
9	9.2				9.2	5.3	173.6
10	9.2				8.3	9.2	90.2
Average	13.05	12.6	23.3	60.4	10.9	10.4	110.5

*The "quick brown fox" sentence

** Free text messages consisting of letters and digits

***Highly formatted messages consisting of letters and digits

Table 2

LEARNING TIME AND MAXIMUM RATE OF DATA ENTRY

Operator	Learning Time	Maximum Rate
1	1½ hrs	14.3 WPM
2	1½ hrs	14.2 WPM
3	1½ hrs	17.2 WPM
4	1½ hrs	16.9 WPM
5	1½ hrs	17.1 WPM
6	1½ hrs	14.5 WPM
7	1½ hrs	11.0 WPM
8	1½ hrs	10.9 WPM
9	1½ hrs	9.2 WPM
10	3 hrs	9.2 WPM

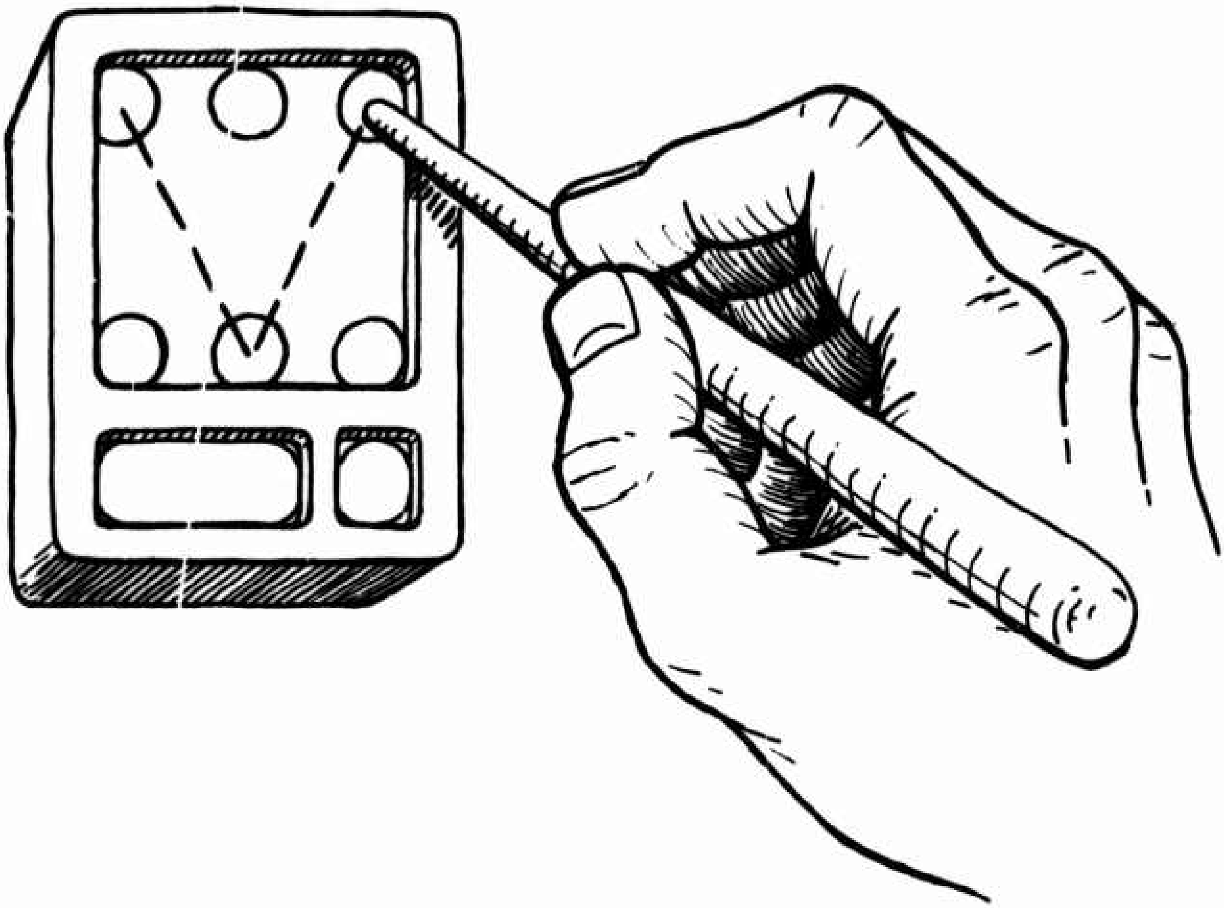


Figure 5. Alpha-dot message entry device tablet type

SELECTED BIBLIOGRAPHY

Englebart, D. C., et al. Advanced intellect augmentation techniques. Final Report: Contract NAS 1-7897, SRI Project 7079. Stanford Research Institute, Menlo Park, California, July 1970.

Hirsch, J. Communication by vibratory tactile stimuli. IRE Transactions on Medical Electronics, PGME-7, December 1956, 29-37.

Miller, G. A. The magical number seven, plus or minus two: some limits on our capacity for processing information. Psychol. Rev., 1956, 27, 81-97.